CLAIMS

Sub B1

1. Method for the modulation of a multicarrier signal with a density $1/(\nu_0.\tau_0)=2$, formed by successive symbols, each comprising M samples to be transmitted and constituted by a set of 2M orthogonal carrier frequencies in the real sense,

the interval between two neighboring carrier frequencies being equal to ν_0 and the interval between the times of transmission of two consecutive symbols, or the symbol time, being equal to τ_0,

each of said carrier frequencies being modulated according to one and the same modulation prototype function g(t) with a truncation length of $2L\tau_0$,

characterized in that it comprises, at each symbol time, the following steps:

- the obtaining of a set of 2M complex coefficients representing data to be transmitted;
- the computing of 2LM linear combinations from said 2M complex coefficients obtained, the weighting coefficients used in these combinations representing said prototype function g(t), so as to obtain 2LM coefficients;
- the summing of said 2LM coefficients weighted in the predetermined storage locations of a memory comprising 2LM storage locations representing 2L groups of M distinct partial sums,

  so as to gradually form, in said storage locations, over a duration of $2L\tau_0$, M samples to be transmitted;
- the transmission of said samples to be transmitted.

2. Method of modulation according to claim 1, characterized in that a sample to be transmitted at the instant $j\tau_0 + k\tau_0/M$, referenced s_{k+jM} is written as follows:

$$s_{k+jM} = \sum_{q=0}^{2L-1} \left[\alpha_{k,q} C_{k,j-q} + \beta_{k,q} C_{k+M,j-q}\right]$$

where: $C_{o,j}$ to $C_{2M-1,j}$ are the 2M complex coefficients generated between the instants

$j\tau_0$ and $(j+1)\tau_0$;

$\alpha_{k,q}$ and $\beta_{k,q}$ are said weighting coefficients.

3. Method of modulation according to claim 2, characterized in that:

- $\alpha_{k,q} = 0$ for q as an odd parity number;
- $\beta_{k,q} = 0$ for q as an even parity number.

4. Method of modulation according to claim 3, characterized in that:it comprises, for the generation of a symbol with an index j formed by M samples, the following steps:

- the obtaining of 2M real inputs $a_{m,n}$ representing a source signal;
- the pre-modulation of each of said real inputs producing 2M complex coefficients;
- the reverse Fourier transform of said 2M complex coefficients producing 2M complex transformed coefficients $C_{0,j}$ to $C_{2M-1,j}$;
- for each of the M pairs ($C_{k,j}$, $C_{(k+M),j}$) of said transformed coefficients, the computation of 2L weighted coefficients, the weighing coefficients representing said prototype function;
- the addition of the result of each of said weighted 2LM values to the contents of the 2LM distinct memory zones so as to gradually build the samples to be transmitted constituting the symbols j, (j+1), (j+2),... (j+2L-1);
- the sending of M samples corresponding to the M oldest contents of said memory zones and then the resetting of the contents of said M memory zones.

5. Method of modulation according ~~any of the~~ to claim~~s~~ 1 ~~to 4~~, characterized in that said steps are implemented at the rate τ_0/M of the samples.

6. Method of modulation according to ~~any of the~~ claim~~s~~ 1 ~~to 5~~, characterized in that said transmission step is followed by a step for the updating of said memory locations comprising:

- a physical shifting of the contents of each of said memory locations if the latter are elements of a shift register; or

- an updating of the write and read addresses of said memory locations, if the latter are elements of a RAM.

7. Method of modulation according to ~~any of the~~ claim~~s~~ 1 ~~to 6~~, characterized in that said coefficients representing data elements to be transmitted are obtained by the implementation of a mathematical transform comprising the following steps:

- the application of a real reverse Fourier transform;
- the circular permutation of the result of this reverse transform by M/2 coefficients leftwards;
- the multiplication of each of said coefficients by i^n.

8. Method of modulation according to ~~any of the~~ claim~~s~~ 1 ~~to 7~~, characterized in that the signal centered on the frequency $M\nu_0$ is written as follows:

$$s(t) = \sum_n \sum_{m=0}^{2M-1} a_{m,n}(-1)^{m(n+L)} i^{m+n} e^{2i\pi m\nu_0 t} g(t - n\tau_0)$$

9. Device for the modulation of a multicarrier signal with a density $1/(\nu_0.\tau_0)=2$, formed by successive symbols, each comprising M samples to be transmitted and constituted by a set of 2M orthogonal carrier frequencies in the real sense,

the interval between two neighboring carrier frequencies being equal to ν_0 and the interval between the times of transmission of two consecutive symbols, or the symbol time, being equal to τ_0,

each of said carrier frequencies being modulated according to one and the same modulation prototype function g(t) with a truncation length of $2L\tau_0$,

characterized in that it comprises:

- means for the temporary storage of 2M groups of M partial sums
- means for the weighting of 2M complex coefficients representing data elements to be transmitted by weighting coefficients representing said prototype function g(t)
- means for the summing of the weighted coefficients in respective predetermined memory locations of said temporary storage locations,

so as to gradually form said samples to be transmitted on a duration of $2L\tau_0$.

10. Modulation device according to claim 9, characterized in that it comprises:

- means of mathematical transformation delivering said coefficients representing data elements to be transmitted at the rate $\tau_0/2M$ and in the following order $(C_{0,j}, C_{M+1,j}),\ldots(C_{M-1,j}, C_{2M-1,j})$;
- 2LM-M simultaneous read/write RAM type memory locations;
- N complex multipliers working at the rate $N\tau_0/2LM$, N being equal to 1, 2, 4,...or 2L.

11. Method for the demodulation of a received signal corresponding to a transmitted multicarrier signal with a density $1/(\nu_0.\tau_0)=2$, formed by successive symbols, each comprising M samples to be transmitted and constituted by a set of 2M orthogonal carrier frequencies in the real sense,
the interval between two neighboring carrier frequencies being equal to ν_0 and the interval between the times of transmission of two consecutive symbols, or the symbol time, being equal to τ_0,
each of said carrier frequencies being modulated according to one and the same modulation prototype function g(t) with a truncation length of $2L\tau_0$,
characterized in that an estimation of 2M real data elements transmitted at a given symbol time is reconstituted by means of the following steps:

- the sampling of said signal received at the sample frequency τ_0/M, delivering M complex samples received;
- the storage of each of said M complex samples received in a predetermined location of an input memory comprising 2ML complex locations, in which there have been previously memorized (2L-1)M samples received during the 2l-1 previous symbol times;
- the multiplication of the 2ML values contained in said input memory by coefficients representing said prototype function;

- temporal aliasing, by the summing up of 2M series of L results of multiplication, so as to obtain 2M complex values;
- the processing of said 2M complex values to form said estimations of the 2M real data elements transmitted.

12. A demodulation method according to claim 11, characterized in that the 2M complex values derived from the temporal aliasing step between the instants $(j+2L-1)\tau_0$ and $(j+2L)\tau_0$ are written as follows:

$$R_{k',j} = \sum_{q'=0}^{2L-1} \alpha'_{k,q}\, r_{k'+(j+q')M}$$

$$R_{k'+M,j} = \sum_{q'=0}^{2L-1} \beta'_{k,q}\, r_{k'+(j+q')M}$$

where:

$r_{k'+(j+q')M}$ represents the sample received at the instant $k'\tau_0+(j+q')\tau_0/M$;

$\alpha'_{k,q}$ and $\beta'_{k,q}$ are said weighting coefficients.

13. Demodulation method according to ~~any of the~~ claim~~s~~ 11 ~~and 12,~~ characterized in that :

- $\alpha'_{k,q'} = 0$ for q' as an odd parity value;
- $\beta'_{k,q'} = 0$ for q' as an even parity value.

14. Method according to ~~any of the~~ claim~~s~~ 11 ~~to 13,~~ characterized in that said processing step comprises the following steps:

- the application of a mathematical transformation that is the reverse of the one performed during the modulation on said 2M complex values delivering 2M transformed values;
- the correction of phase and/or amplitude distortions due to the transmission channel;
- the extraction of the real part of said transformed complex values.

15. Demodulation method according to ~~any of the~~ claim~~s~~ 11 ~~to 14,~~

characterized in that said steps are implemented at the rate τ_0/M of the samples.

16. Device for the demodulation of a received signal corresponding to a transmitted multicarrier signal with a density $1/(\nu_0.\tau_0)=2$, formed by successive symbols, each comprising M samples to be transmitted and constituted by a set of 2M orthogonal carrier frequencies in the real sense,

the interval between two neighboring carrier frequencies being equal to ν_0 and the interval between the times of transmission of two consecutive symbols, or the symbol time, being equal to τ_0,

each of said carrier frequencies being modulated according to one and the same modulation prototype function g(t) with a truncation length of $2L\tau_0$,

characterized in that it comprises:

- means for the sampling of said received signal;
- means for the temporary storage of the complex sample functions comprising 2ML complex locations;
- means for the multiplication of said memorized samples by weighting coefficients representing said prototype function;
- temporal aliasing means summing up L weighting results so as to obtain 2M complex values;
- means for the processing of said complex values delivering an estimation of 2M real data elements transmitted at each symbol time.

17. Demodulation device according to claim 16, characterized in that it comprises:

- means of mathematical transformation that is the reverse of the transformation performed during the modulation on said 2M complex values;
- means for the correction of phase and/or amplitude distortions due to the transmission channel;
- means for the extraction of the real part of said transformed complex values

a 18. Demodulation device according to ~~any of the~~ claim~~s~~ 16 ~~and 17,~~

characterized in that it comprises:

- storage means comprising 2ML-M simultaneous write/read RAM type complex memory locations;
- N complex multipliers working at the $N\tau_0/2LM$ rate, where N is equal to 1, 2, 4 ... or 2L;
- means of mathematical transformation working at the $\tau_0/2M$ rate, whose inputs $R_{o,j}$ to $R_{2M-1,j}$ are read in the order $(R_{0,j}, R_{M,j})$, $(R_{1,j}, R_{M+1,j})$,... $(R_{M-1,j}, R_{2M-1,j})$.

19. A filtering method delivering series of M complex output values at regular intervals from 2L series of 2M complex input values,
said M complex values corresponding to a weighted sum of 2L of said complex input values to be processed,
characterized in that it comprises the following steps for each series of complex input values:

- the computation of 2LM linear combinations from said 2M complex coefficients obtained, the weighting coefficients being derived from 2L complex or real filters with a size M,
so as to obtain 2LM coefficients;
- the summing of each of the weighted values in a predetermined memory location out of a set of 2ML memory locations each containing a partial sum so as to gradually form said output values in said memory locations on a period corresponding to the reception of 2L series of complex input values.

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